Measures for Reducing Energy and Maintenance Costs in Arenas

Operational Measures

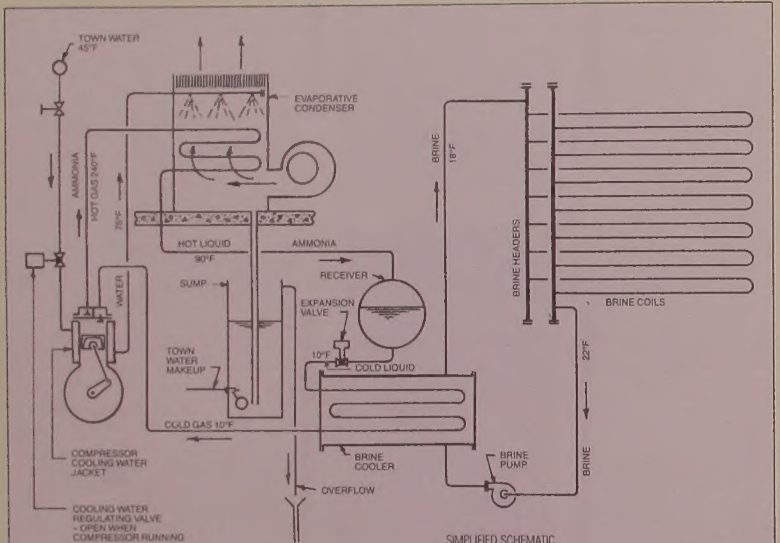
Several essentially no-cost operational measures can substantially reduce operating costs of arenas. One of the most effective measures is to keep the ice as thin as possible — no more than one inch thick. Ice acts as an insulating medium that retards the withdrawal of heat from the ice surface. To maintain a sufficiently hard ice surface, the brine temperature in the ice cooling system must be lowered as the ice thickens. Lower brine temperatures mean less efficiency and longer running times for the ice compressors. Every inch of ice causes compressors to consume 8.4 per cent more energy in the winter and 14.9 per cent more energy in the summer.

A second effective operational measure is to keep resurfacing water to a minimum temperature of 63 degrees C (145 degrees F). This reduces water heating and ice cooling costs.

Keeping ventilation levels to the minimum required by health and safety regulations reduces the cooling load during warmer months and space heating costs during colder months. Minimum ventilation levels are 1.2 litres/second or 2.5 cfm per person. Special care should be taken when engine exhaust is present. Carbon monoxide levels should not be allowed to exceed 35 ppm.

Minimizing the use of spectator heaters can also cut energy consumption, but a balance must be struck between savings and public comfort and opinion. Spectator heaters can be operated on a rotating basis, or some heaters can be turned off with no noticeable impact on comfort levels.

Some arenas cut hot water heating costs by dumping snow outside as an alternative to melting it with hot water. This is possible of course, only when an arena's resurfacing machine room is equipped with an outside door and a convenient dumping area is available.



SIMPLIFIED SCHEMATIC OF ARENA ICE PLANT

Low Cost Retrofits

Installing control valves to reduce the amount of water flowing through the compressor cooling jacket is an effective low cost measure. Cooling water can also be recycled through the cooling jacket. Most compressors, even in the newest arenas, use cooling water only once. (See Schematic Diagrams.)

Brine pump controls are a cost effective and simple means of reducing energy consumption. Brine pump controls turn off the pumps when the compressors are not operating. During most winter months, for example, brine pumps are required to operate only four or five hours each day. Even in warmer months, they rarely have to run more than 16 hours a day.

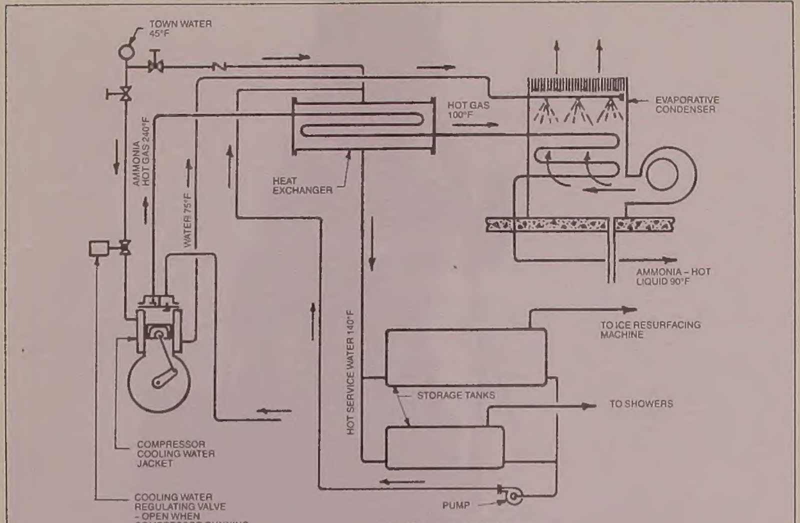
Arena managers can reduce operating costs by allowing ice temperatures to rise to a safe -0.5 degrees C (31 degrees F) overnight. By comparison, the normal daytime temperature is -3 degrees C (26 degrees F). A thermostat (slab thermostat), installed under the ice allows the compressors and the brine pump to be shut down when the

arena is closed each night. When the ice reaches the maximum temperature, the thermostat control automatically switches on the brine pump and compressors.

Electricity costs can be cut matching lighting levels with each rink activity. While hockey, for example, requires high lighting levels, lower levels are usually preferred for recreational skating, and ice maintenance requires minimal lighting. Lower lighting levels also reduce the compressor cooling load. A reduction of 10 kW in lighting levels, for example, cuts compressor electricity demand by between 2 and 4 kW.

Arena operators can minimize lighting costs and improve lighting control by installing several switches, thus allowing lights to be turned off or on in groups. Bright, reflective interior paint and low emissivity ceilings also reduce lighting requirements.

As a final low cost measure, arena managers may also install low-flow 45 second push button taps in dressing room showers. In addition to cutting hot water costs by reducing the flow rate of water and the amount of time the showers operate, push button controls also minimize maintenance costs.



SIMPLIFIED SCHEMATIC ICE PLANT
HOT GAS HEAT RECOVERY

Higher Cost Measures

Insulating the roof of an arena cuts compressor cooling load and lowers maintenance costs. During warmer weather, roof insulation reduces the conduction of heat through the arena's roof, which in turn reduces the amount of heat radiated to the ice surface. The heat radiated from an uninsulated arena ceiling can account for as much as 30 per cent of a compressor's load.

During winter months, roof insulation also prevents condensate from forming on steel ceiling joists or trusses and dripping on the ice surface below. Dehumidifiers by removing moisture from the air, reduce condensation on uninsulated arena ceilings and eliminate ice fog — a common problem in warmer weather. Dehumidifiers and roof insulation both reduce compressor cooling load because they prevent excess water from forming on the ice surface.

Low emissivity ceilings are a comparatively new addition to the list of energy saving equipment available for arenas. They are particularly effective in arenas that operate year round. Constructed of highly reflective polyester film, "Low-E" ceilings are suspended across an arena ceiling on light-weight wires. They save energy by reducing radiant heat flow to the ice surface and in practice cut compressor operating costs from 20 to 30 per cent. The typical payback is less than four years. Low emissivity ceilings also prevent condensate from forming on the ceiling of arenas by keeping the ceiling area temperature above the dew point, and they increase illumination levels by 25 to 50 per cent.

Water deionizing (purification) systems work on the principle that pure water freezes harder, and at a higher temperature (i.e. 0 degrees C or 32 degrees F) than does impure water. Compressor cooling load is reduced and the ice pad can be as much as one third thinner. Deionizing systems also minimize ice resurfacing requirements and the amount of water needed for resurfacing. Deionizing systems are particularly effective energy savers in year-round arenas. Generally, payback periods are in the three-year range.

Some arenas can take advantage of heat recovery systems that transfer compressor waste heat to ice resurfacing, shower and snow melt water. (See Schematic Diagrams.) Heat recovery systems are most economical when the compressor room is close to the ice resurfacing machine room, the snow melting pit and/or the dressing rooms. Heat recovery is uneconomical if heat must be piped long distances.

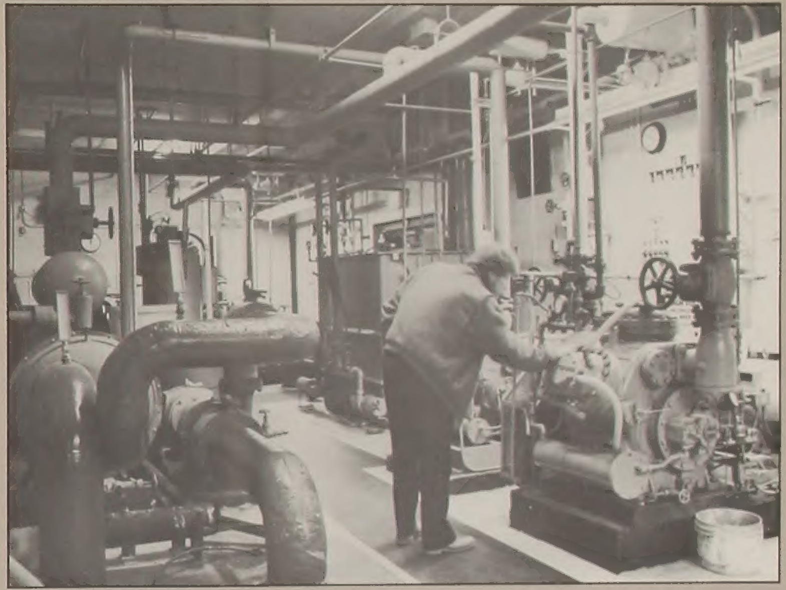
One of the most popular of the higher cost measures, is to replace incandescent, fluorescent and mercury vapour lights with high efficiency metal halide lights. Metal halide lights produce almost as much light as their mercury vapour counterparts, but consume about half the electricity. A major advantage offered by installing metal halide lights is that exact savings can be calculated, based on lower kilowatt consumption.

Insulating the refrigeration system's header trench pipe is a higher cost, but effective measure that reduces compressor cooling load. The amount of heat transferred between the cooling brine and the surrounding air is minimized. The header trench is filled with polyurethane foam. When the foam is applied, the pipe must be dry and the foam must be 100 per cent vapour tight. A 10 year payback is typical.

Additional energy savings can be achieved by a whole range of sophisticated control devices, including programmable thermostats and automatic lighting, heating and ventilating systems.

Computer control and monitoring systems that maintain an optimum balance between requirements and performance, and provide a running check on the efficiency of each piece of equipment are the ultimate. While such sophisticated systems can produce startling results, economy of scale is essential. Computer systems are economic only for very large recreational complexes and/or when several buildings are hooked into one control unit.

Commander Arena



John Agar checks the compressor in the Commander Arena's equipment room.

According to John Agar of the Scarborough engineering department, when the twin pad Commander Arena was built back in 1972, energy efficiency was not an issue. Soon afterwards, however, energy costs jumped and Commander Arena began feeling the pinch. With the economic slowdown of the early 1980's the City of Scarborough realized that something had to be done and a wonderful opportunity presented itself.

A deionized water purification system had just been launched and the producers were looking for a few "guinea pigs" to prove their product's effectiveness. Scarborough was offered a discount of one – third off the regular price. In the first year of operation, the system saved over $8,000 in electricity costs alone.

As Scarborough's energy auditor, it was John's responsibility to find additional cost effective ways to cut energy consumption at the arena. It didn't take long. In 1983, John suggested the installation of an extremely low cost ice slab programmable thermostat in both rinks. Essentially a night set back system, the slab thermostat allows brine temperature to rise to -3 degrees C (26 degrees F) at night before the compressors switch back on. Daytime brine temperatures are kept at -5 degrees C (22 degrees F). The thermostat reduces brine pump,

compressor and condenser operating hours. The payback was excellent. The thermostats, with a $1,100 price tag (including installation), paid for themselves in electricity savings in less than one year.

A heat recovery system that transfers waste heat from the compressors to the snow melting pit was also installed in 1983 for $10,500. Unfortunately, the system was not as cost effective as anticipated. Agar explains, "We had severe corrosion problems because we didn't use the right materials. Eventually we had to replace the original heat recovery unit with a stainless steel heat exchanger that cost us an additional $19,000. The lesson is, you should make sure you do it properly the first time."

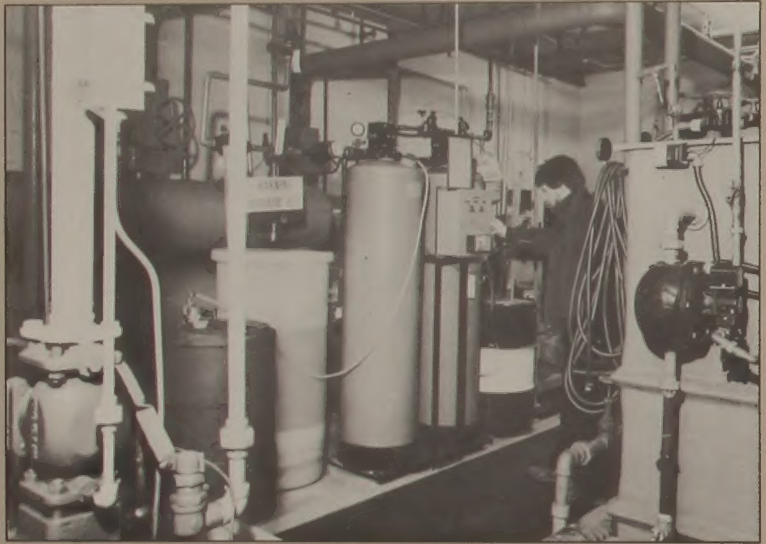
By 1984, it was becoming very obvious that the arena's lighting system was consuming much more electricity than it should. Not only were the VHO (Very High Output) fluorescent lights inefficient, but, they had to be left on all night in warmer weather. According to Agar, when the lights were turned off, condensate formed on the cool lamp surfaces. When the lights were turned on again in the morning, many of the lamps would not work until the condensate evaporated. One solution was to keep the lamps on all night.*

Last June (1985), the fluorescent lights in one of the two arenas were replaced with high efficiency metal halide lamps at an installed cost of $19,000 ($10,000 for the lights and $9,000 for the labour). The new metal halide lights, which use less electricity than the fluorescent lights, will pay for themselves within three years.

According to John Agar, a low emissivity ceiling, installed at the same time, also improved lighting quality, although it was installed primarily to reduce condensation on the ceiling beams, and reduce the cooling load on the compressors. A second Low E ceiling will be installed in the other arena next year.

Although the verdict will not be in until June 1986, Agar is confident that the low emissivity ceiling will peform at least as well as the manufacturer's claim. When he measured the amount of heat radiated from the ceiling before and after the ceiling was installed he found a 90 per cent reduction. Agar calculates that the new ceiling, with an installed cost of $15,700 will reduce refrigeration costs by at least $6,000 a year, resulting in a payback of under three years.

"In addition to saving money, the measures have been well received by the public. People are always commenting on the excellent lighting levels and on the high quality of the ice surface. There's no doubt that we have improved overall quality of the facility."



Deionized water purification systems cut energy costs and create a harder, longer-lasting ice surface.

**This occurs only when lamps are dusty. Water vapour condenses on the cool dusty surface of the fluorescent tubes forming a film of mud which conducts electricity. When the light is turned on, some of the electricity, which would otherwise flow through the tube, is diverted and instead flows along the outside of the lamp. The light will not operate until the moisture on the lamp's surface burns off. Cleaning the lamps would also resolve the problem, but would be costly in terms of labour time.*

A low emissivity ceiling and metal halide lights were installed in one rink at Commander Arena in June 1985 and will be installed in the second rink in June 1986.

PROJECT SUMMARY

DATE: January 1982 MEASURE: Water Deionizing System COST: $11,000 ANNUAL ENERGY COST SAVINGS: $8,000 PAYBACK: 1.4 years	DATE: June 1983 MEASURE: Heat Recovery System (waste heat from compressors used to heat water for ice resurfacing) COST: $10,500 Original system experienced corrosion problems and had to be replaced by a stainless steel unit (see below).	DATE: June 1985 MEASURE: Installed metal halide lights in one rink COST: $19,000 ESTIMATED ANNUAL COST SAVINGS: $4,500 PAYBACK: 4.2 years
DATE: June 1983 MEASURE: Slab thermostats (both rinks) COST: $2,200 (total) ANNUAL ENERGY COST SAVINGS: $3,000* PAYBACK: 0.7 years **Based on 35 hours of compressor shut down per week.*	DATE: November 1984 MEASURE: Replacement of heat recovery system COST: $19,000 ESTIMATED ANNUAL COST SAVINGS: $4,000* PAYBACK: 4.8 years	DATE: June 1985 MEASURE: Installed low emissivity ceiling in one rink COST: $15,700 ESTIMATED ANNUAL COST SAVINGS: $6,000 PAYBACK: 2.6 years

*As there is no meter to measure the amount of hot water used to melt the snow, it is not possible to present actual savings.

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Energy Management of Arenas

The four-year old energy conservation program at Scarborough's twin-pad Commander Arena has cut energy costs and improved quality.

Nothing is more traditionally Canadian than the neighbourhood ice arena. Just as traditional as the arenas themselves, however, is the fact that arenas consume a lot of energy — more per square meter than any other type of municipal building. Ice making, lighting, ventilation, and heating can account for 20 per cent or more of an arena's total operating budget.

In many arenas, however — particularly those built before the energy price increases of the 1970's — up to 40 per cent of the energy consumed is simply wasted. Fortunately, today's energy efficiency know-how and advanced energy efficient products, present a wide range of energy saving options that can fit virtually every municipal budget and situation. In addition to achieving major cuts in energy costs, many of these measures also improve the quality of the arena's facilities and reduce labour and maintenance costs.

But just what are these measures and how much money can they actually save? And how do they work in real life applications? The following case study includes a brief overview of energy saving measures available for arenas, a discussion of the potential cost savings and the experiences of one arena — Commander Arena in Scarborough — which has implemented a number of energy retrofit measures since 1982.

When choosing retrofit measures and before implementation, it is best to draw up a comprehensive plan that incorporates everything from budget, building design and use, the potential *combined* impact of each measure chosen, building maintenance and repair requirements, and even public comfort and attitudes. It also makes sense to start with lower cost measures.

Ontario

Ministry of Energy

Honourable Vincent G. Kerrio
Minister

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